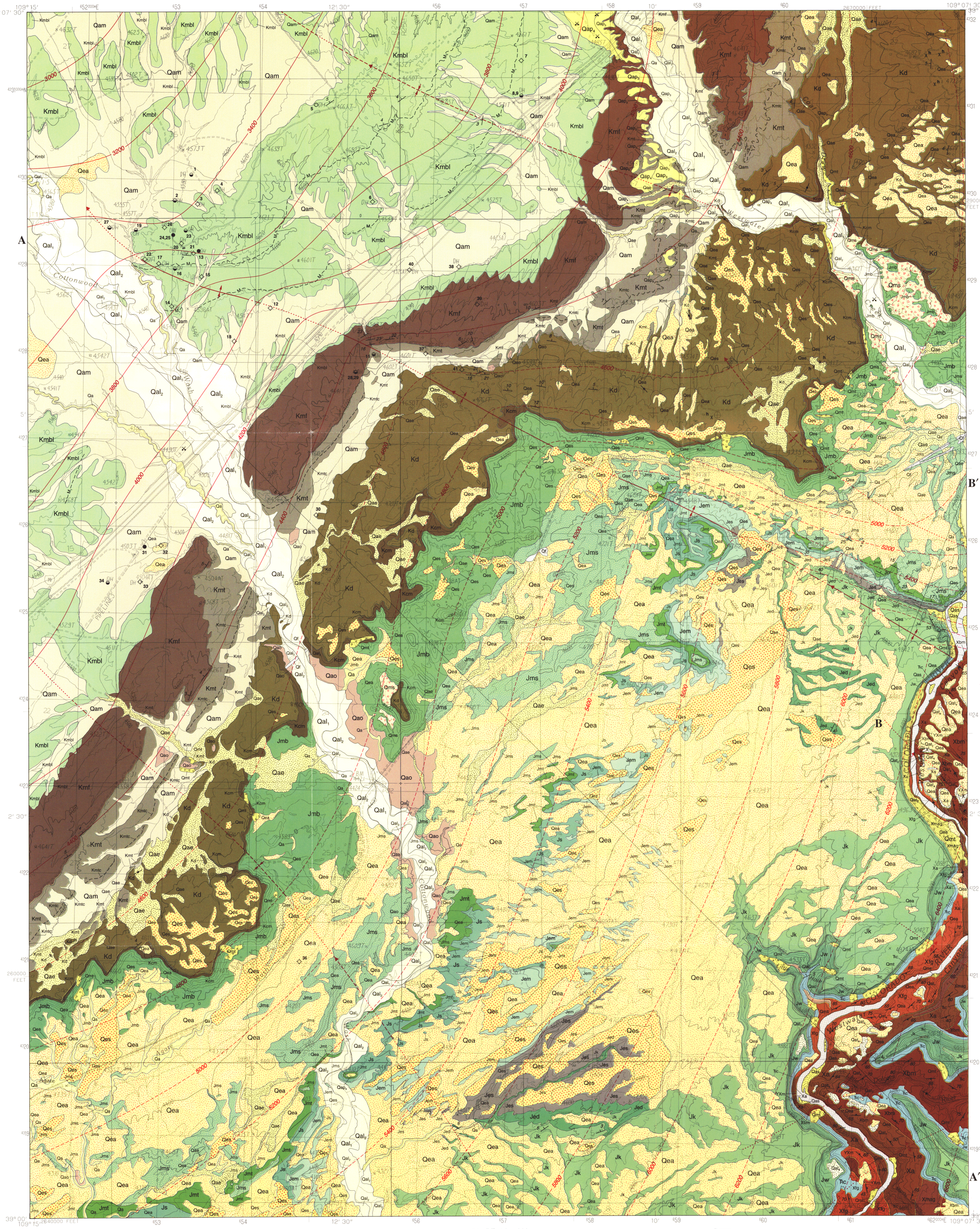
UTAH GEOLOGICAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES

Plate 1
Utah Geological Survey Map 168
Geologic Map of the Agate Quadrangle



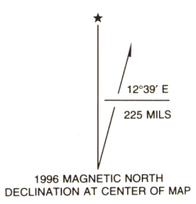
Base from U.S. Geological Survey,
Agate 7.5′ Provisional Quadrangle, 1985

Quadrangle mapped by authors, 1992-93

SCALE 1:24 000

1 .5 0 1 MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET
1 .5 0 1 2 KILOMETERS
1000 0 1000 2000 METERS

CONTOUR INTERVAL 40 FEET
SUPPLEMENTAL CONTOUR INTERVAL 20 FEET



1996 MAGNETIC NORTH
DECLINATION AT CENTER OF MAP

QUADRANGLE LOCATION

1	2	3	1 Antone Canyon 2 Harley Dome 3 Bitter Creek Well 4 Danish Flat 5 Westwater 6 Cisco 7 Big Triangle 8 Marble Canyon
4		5	
6	7	8	

ADJOINING 7.5′ QUADRANGLE NAMES

GEOLOGIC MAP OF THE AGATE QUADRANGLE, GRAND COUNTY, UTAH

by
Grant C. Willis, Hellmut H. Doelling, and Michael L. Ross

1996

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Plate 2
Utah Geological Survey Map 168
Geologic Map of the Agate Quadrangle

DESCRIPTION OF MAP UNITS

QUATERNARY (number subscripts indicate relative age--1 are the youngest (active) and 8 are the oldest mapped Quaternary deposits)

Deposits from human activity

Qf — Fill: Mapped railroad base and dam embankments. Most fill for highways, railroads, and small dams on ephemeral streams was not mapped separately.

Alluvial deposits

Qas — Sand and gravel deposits of the Colorado River: Moderately to well-sorted sand and gravel in the active river channel; inundated and reworked by spring floods; little or no vegetative cover; 0 to 20 feet (0-6 m) thick.

Qa — Alluvial deposits: Poorly to moderately sorted clay- to boulder-size deposits in washes and ephemeral stream channels; materials are from local sources and have undergone limited transport; unit includes other types of deposits too small to map separately; similar to Qae and Qam except confined to better-defined drainages and has a smaller mud and eolian component; 0 to 20 feet (0-6 m) thick.

Qao — Older alluvial deposits: Poorly to moderately sorted, clay- to boulder-size material deposited by streams and sheet wash; form erosional remnants due to later downcutting and dissection; protrude from beneath overlying eolian deposits; 0 to 40 feet (0-12 m) thick.

Qal_1 — Younger alluvial stream deposits: Moderately sorted boulders, cobbles, sand, silt, and clay along washes of perennial streams; contain materials transported from outside of local area; form benches up to 10 feet (3 m) above active drainages; better sorted than Qa deposits; gradational with other Quaternary surficial deposits; range from 0 to about 20 feet (0-6 m) thick.

Qal_2 — Older alluvial stream deposits: Moderately sorted boulders, cobbles, sand, silt, and clay along washes of perennial streams; deposits have been incised 10 to 30 feet (3-9 m) by downcutting of washes; contain materials transported from outside of local area; locally, materials are being deposited on these surfaces from small side washes and adjacent slopes; gradational with other Quaternary surficial deposits; range from 0 to about 30 feet (0-9 m) thick.

Qap_{3-4} — Pediment- and terrace-mantle deposits: Poorly to moderately sorted boulders, cobbles, sand, silt, and clay; form a thin veneer on pediment and terrace surfaces; numbers indicate relative age and height above modern drainages-- Qap_3 ranges from 30 to 50 feet (9-15 m) above adjacent drainages-- Qap_4 from 60 to 100 feet (18-30 m); 0 to 40 feet (0-12 m) thick.

Qat_{5-8} — Terrace gravels deposited by the Colorado River: Moderately to moderately well-sorted cobble- to boulder-size gravel and sand deposited by the Colorado River; isolated on terraces and ledges by continued downcutting of the river; clasts are exotic to quadrangle and come from many miles upstream; range up to 460 feet (140 m) above current river level; numbers indicate relative age and height above modern drainages (see correlation chart, lower right); Qat_3 and Qat_4 are not recognized in quadrangle; 0 to 40 feet (0-12 m) thick.

Eolian deposits

Qes — Eolian deposits: Well- to very well-sorted sand, silt, and minor loess; probably derived from local sandstone units; may include a large component of residuum; blanket benches and broad surfaces where protected from erosion; have a distinctive pale-reddish-orange color imparted by source materials (Jurassic and Triassic "red rock" formations); range from 0 to 80 feet (0-24 m) thick.

Mass-movement deposits

Qms — Landslide deposits: Very poorly sorted boulder- to clay-size material on slopes; hummocky upper surface; contains boulders up to 20 feet (6 m) in diameter; derived from Morrison and Cedar Mountain Formations; locally include talus and colluvial deposits; 0 to 50 feet (0-15 m) thick.

Qmt — Talus deposits: Very poorly sorted, angular boulders and lesser smaller-size materials on, and at base of, steep slopes; derived from resistant overlying units; small deposits are not mapped separately; 0 to 30 feet (0-9 m) thick.

Mixed-environment deposits

Qam — Alluvial mud and sheet-wash deposits: Moderately well-sorted silt, clay, and some sand; locally with minor coarse clastic or eolian deposits; mostly sand near outcrops of Dakota Sandstone; cover broad surfaces with poorly developed drainages; derived primarily from the Mancos Shale and the middle part of the Dakota Sandstone; gradational with units Qal_1, Qal_2, Qae, and Qea; range from 0 to 20 feet (0-6 m) thick.

Qac — Mixed alluvial and colluvial deposits: Poorly to moderately sorted, clay- to boulder-sized material deposited in channels near steep slopes; many smaller deposits are not mapped separately; locally contain abundant eolian materials; gradational with other Quaternary surficial deposits; 0 to 20 feet (0-6 m) thick.

Qae — Mixed alluvial and eolian deposits: Moderately to well-sorted clay- to boulder-sized material; dominated by alluvial processes; present in areas with minor to moderate erosion where eolian deposits have had time to accumulate; eolian component varies from locally absent to moderate; intermediate between, and gradational with, Qa and Qea; similar to Qam but there is more sand and less clay and silt; 0 to 30 feet (0-9 m) thick.

Qea — Eolian and alluvial deposits: Moderately well- to very well-sorted sand, silt, loess, and local gravel; eolian component generally more abundant than alluvial component; have a distinctive reddish-orange color imparted by eolian source materials (Jurassic and Triassic "red rock" formations); present on older surfaces in areas of limited alluvial influence; gradational with other surficial deposits; range from 0 to 40 feet (0-12 m) thick.

unconformity

CRETACEOUS

Kmbl — Lower part of the Bluegate Shale Member of the Mancos Shale: Medium- to dark-gray, brownish-gray, or black mudstone, siltstone, and shale; weathers to pale gray; contains 0.5 to 2 inch (1-5 cm) thick layers of white to light-gray bentonite and a few thin, very fine-grained sandstone beds; rare bivalves, ammonites, gastropods, and fish scales; trace fossils are locally common; bedding is poorly developed and is generally lenticular; heavily weathered at surface; preserved part of unit is about 1,500 to 1,600 feet (450-480 m) thick; upper part not preserved in quadrangle; includes two thin sandstone marker beds, M_1 and M_2.

Kmf — Ferron Sandstone Member of the Mancos Shale: Medium- to dark-gray, interlayered mudstone and siltstone, and pale- to medium-grayish-brown, medium- to very fine-grained sandstone; locally, base is a coarse sandstone up to 5 feet (1.5 m) thick with scattered grit and rare pebbles up to 0.5 inch (1 cm) in diameter and with rare fish teeth; sandstone forms coarsening upward sequences that are generally 1 to 5 inches (1-12.5 cm) thick; bivalves, trace fossils, and calcite-cored concretions are locally present; has ripple laminations, sole marks, and horizontal to lenticular bedding; gradational upper contact; forms a low cuesta; unit is about 100 to 125 feet (30-38 m) thick.

Kmt — Tununk Shale Member of the Mancos Shale: Medium- to dark-gray, brownish-gray, or black mudstone, siltstone, and shale; weathers to pale gray; contains several 0.5 to 2 inch (1-5 cm) thick layers of white to light-gray bentonite and a few dense, thin, very fine-grained sandstone beds; has pods of dark-gray aragonite up to 3 inches (7.5 cm) thick; fossils and trace fossils are locally common; oyster shells are locally abundant near the base of the unit; bedding is poorly developed and is generally lenticular; 150 to 190 feet (45-57 m) thick.

Kmtc — Coon Spring Sandstone Bed of the Tununk Shale Member: Medium- to dark-brownish-gray, silty shale and mudstone with interbedded yellowish-brown to pale-gray, thin, platy, very fine-grained sandstone, mudstone, and calcareous sandstone concretions; locally fossiliferous; sandstone forms very thin beds up to about 3 inches (7.5 cm) thick; large rounded sandstone concretions are up to about 6 feet (2 m) in diameter; calcareous sandstone concretions are up to 3 feet (1 m) in diameter and are sparitic to fibrous; generally forms mound or swell littered with resistant concretions about 100 feet (30 m) above base of Tununk; the sandstone or calcareous sandstone concretions are commonly the only well exposed part of the unit; gradational upper and lower contacts; unit is 35 to 45 feet (11-14 m) thick; mapped as a marker bed because lower and upper contacts are poorly exposed.

Kd — Dakota Sandstone: Pale-yellowish-orange, yellowish-gray, or gray, fine- to coarse-grained, quartz sandstone and conglomeratic sandstone and medium- to dark-gray carbonaceous shale and mudstone. Lower part is medium- to thick-bedded and generally cross-bedded sandstone and conglomerate, conglomerate is lenticular and discontinuous, clasts in the conglomerate are generally less than 1 inch (2.5 cm) in diameter, dense ironstone concretions are abundant. Middle part is medium- to dark-gray carbonaceous shale, mudstone, thin coal, and lenticular fine- to medium-grained, thin- to thick-bedded, cross-bedded, channel sandstone deposits; has volcanic ash layers with some plant fossils, coal ranges from 0.5 to 2 feet (0.15-.6 m) thick. Upper part is fine- to medium-grained sandstone that contains scattered quartzite cobbles up to about 2 inches (5 cm) in diameter; upper contact is a sharp, irregular surface; forms a resistant cliff throughout quadrangle. Unit is 90 to 120 feet (27-36 m) thick.

unconformity

Kcm — Cedar Mountain Formation: Pale-greenish-gray, thin- to medium-bedded sandstone and mudstone; locally has large lenticular channel deposits of medium to coarse sandstone; 60 to 100 feet (18-30 m) thick.

JURASSIC

Jmb — Brushy Basin Member of Morrison Formation: Variegated, red, maroon, light-green, gray, and white shale and mudstone interbedded with varying amounts of argillaceous sandstone, conglomeratic grit, thin lenses of dense gray limestone, and nodular limestone; forms steep slope; 380 to 420 feet (116-128 m) thick.

Jms — Salt Wash Member of Morrison Formation: Interbedded sandstone and mudstone; sandstone is light to yellow gray, medium to coarse grained, cross-bedded in lenticular beds as much as 20 feet (6 m) thick, and resistant; mudstone is generally red with less common green horizons, and forms slopes; about 200 to 250 feet (61-76 m) thick.

Jmt — Tidwell Member of Morrison Formation: Lavender and brown mudstone containing nodular, gray, hard limestone horizons and local large concretions of white chalcedony and quartz; slope forming; 20 to 45 feet (6-14 m) thick.

J-5 unconformity

Js — Summerville Formation: Gray, tan, and brown sandstone; mostly fine grained, thin bedded, and ledge forming in upper part; reddish, slope-forming, fine-grained silty sandstone and claystone in lower part; 40 to 55 feet (12-17 m) thick.

Je — Entrada Sandstone: shown on cross section only.

Jem — Moab Member of Entrada Sandstone: White sandstone, fine- to medium-grained, well-rounded grains; generally in massive resistant beds, tops of beds weather into polygonally fractured blocks; 70 to 80 feet (21-24 m) thick.

J-3 unconformity? (eolian cross-beds in Slick Rock Member are truncated at contact with Moab Member)

Jes — Slick Rock Member of Entrada Sandstone: Light-brown or buff, light-reddish-brown or salmon-colored, pinkish-orange sandstone; chiefly very fine- to fine-grained, rounded to well-rounded, moderately well-sorted subarkosic arenite; occasional medium- to coarse-grained quartz sand along cross-bed laminae; calcareous, poorly cemented; horizontal bedding and large-scale eolian cross-bedding; forms bare, smooth cliffs and steep rounded hills; about 140 to 150 feet (43-46 m) thick.

Jed — Dewey Bridge Member of Entrada Sandstone: Pale-reddish-brown to light-brown, moderate-reddish-brown, silty sandstone interbedded with very pale-orange, grayish-orange, pale-yellowish-orange sandstone; colors commonly mottled; black specks of residual oil are common in yellowish-orange sandstone; sandstone is generally very fine- to fine-grained, subrounded to rounded, moderately sorted subarkosic arenite, calcareous, and poorly cemented; silty sandstone is generally very fine to medium grained, subangular to rounded, moderately sorted, calcareous, and moderately indurated; within beds are indistinct areas of disturbed thin to thick laminae; basal contact is sharp erosional truncation surface on which detrital chert granules, pebbles, and cobbles are widespread; sparse stringers of coarse-grained quartz and chert in basal sandstone; forms irregular rounded ledges and rubbly slope; about 25 to 35 feet (8-11 m) thick.

J-2 unconformity

Jk — Kayenta Formation: Grayish-red-purple, pale-red-purple, pale-reddish-brown sandstone, intraformational conglomerate, and siltstone interbedded with bluish-white to very light-gray sandstone; wedge-shaped to tabular sandstone packages of very fine- to medium-grained, subrounded, moderately to well-sorted feldspathic to lithic arenite; thinly laminated to thick bedded; small- to large-scale cross-bedding; intraformational conglomerate contains rip-up clasts of siltstone and mudstone; poorly sorted; small-scale trough cross-bedding; calcareous, well-indurated; thick to massive bedding; forms step-like ledgy cliffs and slopes; gradational and irregular contact with underlying Wingate Sandstone; about 200 feet (60 m) thick.

Jw — Wingate Sandstone: Grayish-orange-pink and light-brown quartz sandstone; very fine to fine grained; grains are rounded, well sorted, and frosted; calcareous; well cemented; horizontal bedding to large-scale eolian cross-bedding; interbedded ripple-laminated sandstone and thinly laminated siltstone at base; forms massive cliff or step-like massive ledges; commonly coated with a veneer of dark-rusty-red to black desert varnish; about 300 feet (90 m) thick.

J-0 unconformity

TRIASSIC

Trc — Chinle Formation: Reddish-brown, grayish-red, pale-brown, and pale-red siltstone, sandstone, mudstone, limestone, and pebble conglomerate and sparse pale-green limestone and mudstone; predominantly siltstone and fine-grained sandstone; siltstone is calcareous, indurated, structureless to horizontally laminated, and has a few vertical burrows in upper part; sandstone is fine grained, moderately sorted, calcareous, well cemented, and is locally ripple laminated to trough cross-bedded; at some locations at the top of the formation there is a lens 5 to 10 feet (1.5-3 m) thick of thick-bedded, fine- to medium-grained, moderately sorted, quartzose sandstone; at the base of the formation pebble conglomerate forms discontinuous gravel lenses containing abundant angular to subrounded metamorphic and granitic rock clasts; about 70 to 110 feet (21-33 m) thick.

Tr-3 unconformity

EARLY TO MIDDLE PROTEROZOIC Note: Dike-like and irregular bodies of granitic pegmatite, aplite, and lamprophyre cross-cut all gneissic units; bodies are generally linear, small, and discontinuous; pegmatites may be late phases of quartz monzonite intrusion southeast of map area. They are too small and scattered to map separately.

YXu — Undivided metamorphic and igneous rock: Shown in cross section only.

YXm — Altered mafic and ultramafic rock: Non-foliated, strongly metasomatized rock with generally equigranular, fine-grained texture that overprints medium- to coarse-grained amphibole and plagioclase, mostly altered to chlorite, clay minerals, and serpentine, carbonate, and hematite; forms small, dark-greenish-black to dark-brownish-black, pipe-like bodies; weathers to debris-covered black knobs.

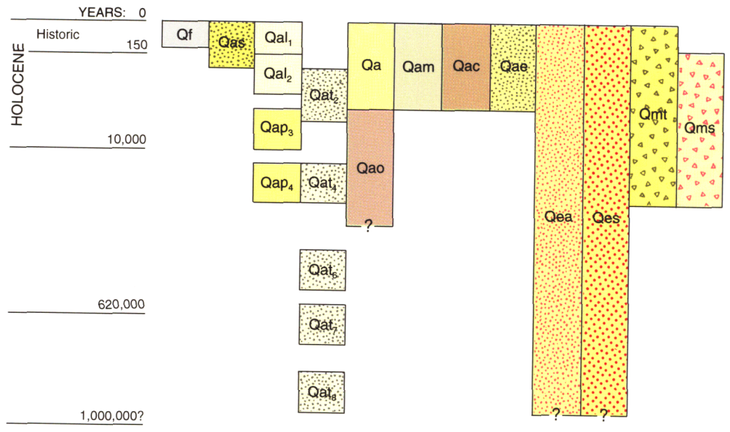
Xbm — Biotite-microcline gneiss: Fine- to medium-grained gneiss composed of quartz, K-feldspar, plagioclase, biotite, and rare sillimanite; well foliated; thinly layered; highly deformed; locally migmatitic; forms light- and dark-banded, bouldery outcrops; interlayered with amphibolite (Xa) bodies at Westwater Canyon; thought to be meta-sedimentary.

Xmag — Microcline augen gneiss: Distinctive pinkish-gray to "salt and pepper" colored gneiss composed of large (up to 1 inch; 2.5 cm) subhedral "birds-eye" structures that are either augen of microcline or recrystallization aggregates in a fine- to medium-grained groundmass of plagioclase, quartz, biotite, and minor muscovite; forms foliated sill-like masses; thought to be meta-igneous.

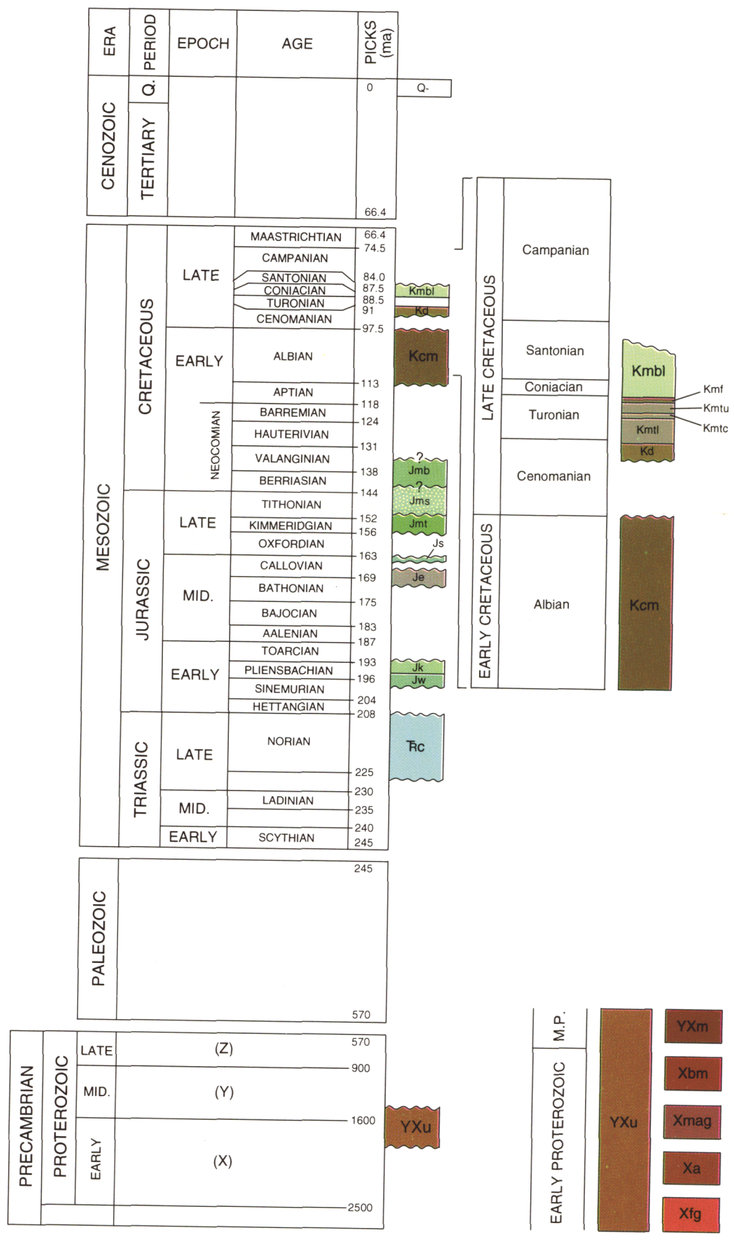
Xa — Amphibole gneiss and amphibolite: Characterized by fine- to medium-grained amphibole, quartz, plagioclase, K-feldspar, trace amounts of garnet and apatite; forms dark-gray to black sill-like masses or layers in and adjacent to the feldspathic gneiss (Xfg); most of the unit is structurally above the feldspathic gneiss and below the biotite-microcline gneiss (*Xbm*); *thought to be meta-igneous* (basaltic sills and flows).

Xfg — Feldspathic gneiss: Medium- to coarse-grained, homogeneous quartz-feldspar gneiss that contains abundant biotite and minor amphibole, apatite, sphene, garnet, and opaque minerals; well foliated, prominent mineral lineations are pervasive; forms light-pinkish-gray to black bouldery outcrops; thought to be meta-igneous (flows, ignimbrite sheets or sills).

CORRELATION OF SURFICIAL DEPOSITS

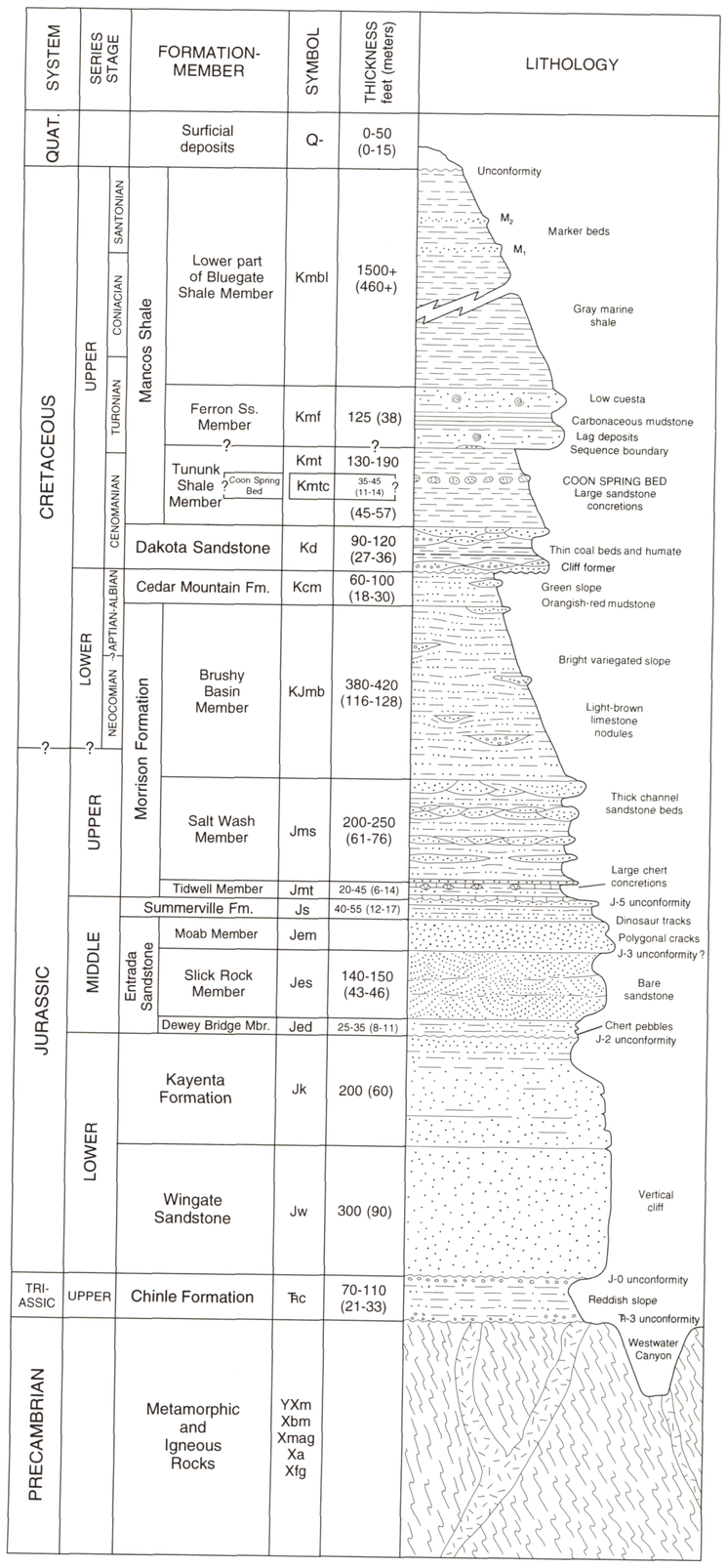


CORRELATION OF BEDROCK UNITS



Scale modified from Palmer, 1983.

LITHOLOGIC COLUMN



MAP SYMBOLS

Contact

Marker bed (M_1 and M_2)

Fault-- dotted where concealed; bar and ball on downthrown side

Trace of axial surface of folds-- arrow on axis shows direction of plunge, dashed where approximately located, dotted where concealed

Syncline

Monocline (overprinting older broad anticline)

Antiform in metamorphic rocks

Synform in metamorphic rocks

4400 — Structural contours-- 200-foot (60 m) contour interval; datum is top of Dakota Sandstone; dashed line shows where datum surface is projected above the ground.

4 — Strike and dip of bedding

Strike of near-vertical joints

68 — Strike and dip of metamorphic foliation (from Case, 1991)

Strike of vertical metamorphic foliation (from Case, 1991)

Gravel or borrow pit

X h — Prospect pit-- H= humate; not labeled= unknown

13 — Oil well

28 — Oil and gas show

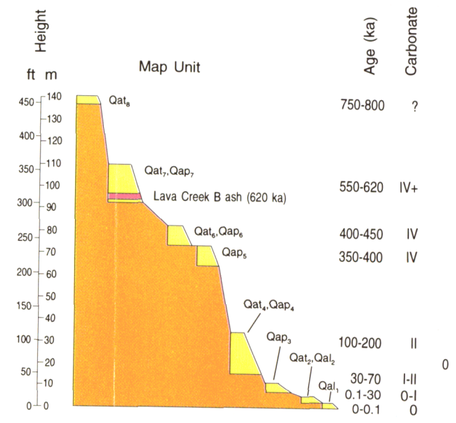
23 — Drill hole-- with show of oil, abandoned

5 — Drill hole-- with show of gas, abandoned

4 — Drill hole-- dry and abandoned

(Note: Numbers refer to table 1 in text booklet)

CORRELATION OF PEDIMENT AND TERRACE DEPOSITS



Pediment- and terrace-mantle deposits form erosional remnants up to 460 feet (140 m) above adjacent active drainages. Height above drainages, amount of pedogenic carbonate development, and comparison with nearby deposits of known age is used to estimate age and correlation of these deposits (Willis, 1992 and 1994). See discussion in the text. Mapped deposits without number subscripts generally have a wider age range.